MODULAR COOLING LOOP SYSTEM

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to cooling systems, and more particularly to cooling systems for industrial applications.

[0002] Some known plastic molding processes include injecting molten resin into a cavity in an injection die mold. The mold is closed and compressed and then cooled to solidify the plastic resin. Usually the cooling is accomplished by circulating water through cooling channels in the die mold to lower the temperature of the plastic resin. In some processes, plant water is used as the cooling medium, and in other processes, chilled water is used as the cooling medium.

[0003] For quality molded parts, the rate of heat removal from the die mold during the cooling cycle of the molding process should be repeatable by controlling both temperature and flow rate of the coolant so that the die is cooled to the same rate each time a part is molded in the die. The temperature of the coolant as well as the flow rate and heat load should be indicated so that the required cooling conditions for a specific mold can easily and be achieved and verified.

[0004] Some known plastic molding process incorporate a chiller coupled to each die mold to supply constant temperature cooling water. The chiller includes a refrigeration circuit that has a compressor, a water cooled condenser, a filter/dryer, and a refrigerant evaporator. Such individual chillers add complexity and cost to the molding process and also require added maintenance.

[0005] Some known plastic molding process incorporate a central chilled water supply system serving multiple molding machines. Such systems may not provide independent temperature control at each injection machine. Such systems may also operate with low return temperatures to the chiller since the chiller and pump system supports the full flow required by each of the machine molds and molding machine molds typically require high flow rates with a low temperature rise.

BRIEF DESCRIPTION OF THE INVENTION

[0006] In one aspect, a modular cooling loop system for cooling a manufacturing process machine is provided. The cooling loop system connects to a chilled water supply system and the manufacturing process machine. The cooling loop system includes a movable chassis and a coolant piping loop mounted on the chassis. The coolant piping loop includes a pump, a plurality of coolant inlets a plurality of coolant outlets, a plurality of temperature sensors for measuring coolant temperature in the coolant piping loop, a flow sensor for measuring coolant flow in the coolant piping loop, and a flow control valve for controlling the flow of fresh coolant into the coolant piping loop. The coolant piping loop is configured to recirculate coolant through the coolant piping loop and the manufacturing process machine.

[0007] In another aspect, a portable cooling loop system for cooling a manufacturing process machine is provided. The cooling loop system is connectable to a chilled water supply system and the manufacturing process machine. The cooling loop system includes a chassis having a plurality of wheels to make the chassis movable, and a coolant piping loop mounted on the chassis. The coolant piping loop includes a main cooling water inlet line configured to connect to the chilled water supply system. The main cooling water inlet includes a first temperature sensor. The piping loop also includes a pump, at least one cooling water outlet configured to connect to the manufacturing process machine to supply cooling water, at least one cooling water inlet configured to connect to the manufacturing process machine to receive spent cooling water, a main cooling water outlet configured to connect to the chilled water system, a flow control valve located in the main cooling outlet line, a second temperature sensor located upstream from the at least one cooling water outlet, and a third temperature sensor located down stream from the at least one cooling water inlet.

[0008] In another aspect, a method of cooling a manufacturing process machine is provided. The method includes coupling a modular cooling loop system to the process machine, coupling the modular cooling loop system to a chilled

water system, and circulating chilled water coolant through the process machine utilizing the modular cooling loop system to maintain a pre-selected process temperature and a pre-selected coolant flow rate. The modular coolant loop system includes a movable chassis, and a coolant piping loop mounted on the chassis. The coolant piping loop includes a pump, a plurality of coolant inlets, a plurality of coolant outlets, a plurality of temperature sensors for measuring coolant temperature in the coolant piping loop, a flow sensor for measuring coolant flow in the coolant piping loop, and a flow control valve for controlling the flow of fresh coolant into the coolant piping loop. The coolant piping loop is configured to recirculate coolant through the coolant piping loop and the manufacturing process machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 is schematic illustration of a modular cooling loop system connected to a manufacturing process machine in accordance with an embodiment of the present invention.

[0010] Figure 2 is a more specific schematic illustration of the modular cooling loop system shown in Figure 1.

[0011] Figure 3 is a side schematic view of the modular cooling loop system shown in Figure 1.

[0012] Figure 4 is a front schematic view of the modular cooling loop system shown in Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

[0013] A modular cooling loop system is described in detail below. An exemplary embodiment of the cooling loop system includes wheels to make the system portable. The modular cooling loop system maintains a constant flow and temperature of coolant used to cool a manufacturing process machine, for example, an injection molding machine. Maintaining a more constant coolant flow and temperature than known cooling systems increases productivity of the molding

machine by reducing cycle time. Injection machines are often required to make parts of various sizes with different molds having specific flow requirements. The modular cooling loop system is a coolant control system that makes it possible to easily reproduce specific flow and temperature requirements for a specific mold. Additionally, while the cooling loop system pump circulates the required flow through the process machine, the flow rate required from the chilled water supply system is significantly lower than the flow rate through the process machine due to the chilled water supply system water temperature being lower than the required process machine inlet temperature. When multiple process machines are serviced by the chilled water supply system, this characteristic of the cooling loop system makes it possible to provide the flow required at the process machine with less total pumping power since the chilled water supply system pumps are not required to pump the total system flow accounting for a high head pressure required by the process machine.

[0014] Referring to the drawings, Figure 1 is a schematic illustration of an exemplary embodiment of a modular cooling loop system 10 connected to a manufacturing process machine 12 and a chilled water coolant system 14 in accordance with an embodiment of the present invention. Figure 2 is a more specific schematic illustration of modular cooling loop system 10, Figure 3 is a side schematic view of modular cooling loop system 10, and Figure 4 is a front schematic view of modular cooling loop system 10. Referring to Figures 1-4, cooling loop system 10 includes a coolant piping loop 16 mounted on a chassis 18. A plurality of wheels 19 are attached to chassis 18 to permit easy portability of modular cooling loop system 10.

[0015] Piping loop 16 includes a pump 20 for circulating coolant through piping loop 16. A main coolant inlet line 22 connects piping loop 16 to chilled water coolant system 14 and permits chilled water coolant to flow into piping loop 16. A main coolant outlet line 24 connects to piping loop 16 at a location upstream from the connection of main input line 22. A plurality of coolant outlets 26 are located downstream from main coolant inlet line 22 and are used to connect piping loop 16 to manufacturing process machine 12 to permit chilled water coolant to enter

process machine 12 to moderate the temperature of process machine 12. A plurality of spent coolant inlets 28 are located upstream from main coolant outlet line 24 and are used to connect piping loop 16 to manufacturing process machine 12 to permit the water coolant to exit process machine 12 and reenter piping loop 16.

[0016] A flow control valve 30 is located in main coolant outlet line 24 and controls the amount of water that is circulated back to chilled water coolant system 14 to be re-chilled. A programmable logic controller 32 mounted on chassis 18 is operatively connected to flow control valve 30 and sends control signals to valve 30 to control the flow of water flowing through main outlet line 24

[0017] A first temperature sensor 34 is located in main coolant inlet line 22 to measure the temperature of the chilled water coolant entering piping loop 16. A second temperature sensor 36 is located downstream from pump 20 and upstream of coolant outlets 26 to measure the temperature of the water coolant before it flows into manufacturing process machine 12. A third temperature sensor 38 is located between coolant inlets 28 and main coolant outlet line 24 to measure the temperature of the water coolant leaving manufacturing process machine 12. Temperature sensors 34, 36, and 38 are operatively coupled to programmable logic controller 32.

[0018] A flow sensor 40 is located downstream of pump 20 to measure the flow of the water coolant in piping loop 16. Flow sensor 40 is operatively coupled to programmable logic controller 32. A pump controller 42 is mounted on chassis 18 and is operatively coupled to pump 20 and programmable controller 32. Pump controller 42 can be any suitable controller, for example, a variable frequency drive controller.

[0019] In operation, modular cooling loop system 10 is connected to manufacturing process machine 12 through coolant outlets 26 and inlets 28, and is connected to chilled water coolant system 14 through main coolant inlet 22 and main coolant outlet 24. A desired temperature of process machine 12 is entered into programmable controller 32 by an operator along with the desired flow rate. Pump 20

is energized and is adjusted by pump controller 42 based on the input from flow sensor 40 to achieve the desired flow rate through piping loop 16. Temperature sensors 34, 36, and 38 monitor the temperature of the water coolant. When the temperature of the water coolant exiting process machine 12 is above the desired processing temperature, programmable controller 32 adjusts flow control valve 30 in main coolant outlet line 24 to permit some of the coolant water to return to chilled water system 14. This causes an equal volume of coolant water at a lower temperature to enter piping loop 16 and mix with the warmer coolant water circulating in piping loop 16. Programmable logic controller 32 also monitors the temperature measured by temperature sensor 36 to determine whether the coolant supplied to manufacturing process machine 12 is at the desired temperature. Specifically, programmable logic controller 32 monitors the outputs of temperature sensors 34, 36, and 38 and the output of flow sensor 40 and adjusts the flow of coolant water to and from chilled water system 14 to maintain the temperature of coolant water in piping loop 16 at the desired temperature by adjusting flow control valve. In one exemplary embodiment, the temperature of coolant water in piping loop 16 is maintained at the desired temperature ± 0.5°F.

[0020] The above described modular coolant loop system 10 maintains a constant flow and a constant temperature of coolant used to cool manufacturing process machine 12. Modular coolant loop system 10 is portable and can easily be moved from one process machine to another to satisfy production schedules. Maintaining constant coolant temperature and constant coolant flow increases productivity of a molding machine, for example, an injection molding machine, by reducing cycle time, and also increases product quality and consistency.

[0021] While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.